CLASSIFICATION ANALYSIS OF VIBRATION DATA FROM SH-60B HELICOPTER TRANSMISSION TEST FACILITY

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The U.S. Navy is currently evaluating an integrated diagnostic system for its rotary wing aircraft. The system is referred to as the Health Usage and Monitoring Systems (HUMS). The program's objective is to develop an automated diagnostic system that can identify mechanical faults within the power train of helicopters using vibration analysis. This thesis uses data provided by the Helicopter Transmission Test Facility at the Naval Air Warfare Center, Trenton, New Jersey. The goal of this thesis is to conduct data analysis to identify a fault within the helicopter test transmission using a tree-structured model. Prior to conducting tree analysis, an attempt is made to reduce the amount of data by principal component analysis. All statistical analysis was completed with S-Plus Software (MathSoft Inc., 1995).

STUDY OF INITIAL ENTRY STUDENT ATTRITION FROM THE DEFENSE LANGUAGE INSTITUTE FOREIGN LANGUAGE CENTER

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The Defense Language Institute Foreign Language Center (DLIFLC) trains students in foreign languages for the Department of Defense. The majority of the students in the basic courses of instruction are enlisted personnel with less than one year of military service. This study analyzes attrition from the basic language courses in an attempt to clarify an observed increase in attrition for fiscal years 1994 to 1996. Students who attire from languages that are difficult for native English speaking students to learn are sometimes enrolled in the easier basic Spanish course. DLIFLC management was interested in evaluating the effect this influx of previously attired students had on the attrition from the basic Spanish course. The population of DLIFLC students is described by graphically displaying how attrition is related to several variables which describe the students. Analysis of attrition from four specific languages of varying difficulty and the basic Spanish course was performed using binary tree classification. Results show the variation in attrition for fiscal years 1994 to 1996 was consistent with historical data and students who entered the Spanish course after attiring from another language affected attrition for administrative reasons, but not for academic reasons.

KNAPSACK CUTS AND EXPLICIT-CONSTRAINT BRANCHING FOR SOLVING INTEGER PROGRAMS

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Enhanced solution techniques are developed for solving integer programs (IPs) and mixed-integer programs (MIPs). Previously unsolvable problems can be solved with these new techniques. We develop knapsack cut-finding procedures for minimal cover cuts, and convert existing cut-strengthening theory into practical procedures that lift and tighten violated minimal cover valid inequalities to violated knapsack facets in polynomial time. We find a new class of knapsack cuts called "non-minimal cover cuts" and a method of lifting them called "deficit lifting." Deficit lifting enables all of these cuts to be lifted and tightened to facets as well. Extensions of these techniques enable us to find cuts for elastic knapsack constraints and cuts for non-standard knapsack constraints. We also develop the new technique of "explicit-constraint branching" (ECB). ECB enables the technique of constraint branching to be used on IPs and MIPs that do not have the structure required for known "implicit constraint branching" techniques. When these techniques are applied to 84 randomly generated generalized assignment problems, the combination of knapsack cuts and explicit-constraint branching were able to solve 100 percent of the problems in under 1000 CPU seconds. Explicit constraint branching alone solved 94 percent, and knapsack cuts solved 93 percent. Standard branch and bound alone solved only 38 percent. The benefits of these techniques are also demonstrated on some real world generalized assignment and set-partitioning problems.

A CASCADE APPROACH FOR STAIRCASE LINEAR PROGRAMS WITH AN APPLICATION TO AIR FORCE MOBILITY OPTIMIZATION

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We develop a method to approximately solve a large staircase linear program that optimizes decisions over time. Also developed is a method to bound that approximation's error. A feasible solution is derived by a *proximal cascade*, which sequentially considers overlapping subsets of the model's time periods, or other ordinally defined set. In turn, we bound the cascade's deviation from the optimal objective value by a *Lagrangian cascade* which penalizes unfeasibility by incorporating dual information provided by the proximal cascade solution. When tested on a large temporal LP developed for U.S. Air Force mobility planners, we often observe gaps between the approximation and bound of less than 10 percent, and save asmuch as 80 percent of the time required to solve the original problem. We also address methods to reduce the gap, including constraint extension of the *Lagrangian cascade*, as well as exploitation of dual multipliers within the proximal cascade.

SCHEDULING ATTACK SUBMARINE DEPLOYMENTS

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The Navy's peacetime mission is "to conduct forward presence operations to help shape the strategic environment by deterring conflict, building interoperability, and by responding, as necessary, to fast breaking crises with the demonstration and application of credible combat power," (OPNAV INSTRUCTION 3501.316, February 1995). The ability to carry out this mission hinges on the Navy's ability to maintain ships and submarines forward deployed in regions where such crises may occur.

The end of the Cold War and current budget constraints have caused a drawdown in the number of ships and submarines with which to provide forward presence. Coupled with the continued requirement to maintain a certain level of forward presence, this drawdown creates shortfalls when attempting to deploy ships or submarines to fill certain mission requirements.

To minimize these shortfalls, this thesis formulates the problem of scheduling attack submarine deployments as an integer program. Due to its size and complexity, heuristic algorithms are developed to provide near-optimal solutions in a reasonable amount of time. In addition to providing near-optimal deployment schedules, results from the algorithms are also useful in evaluating changes in maintenance and operational policies.

LOGISTICAL IMPLICATIONS OF OPERATIONAL MANEUVER FROM THE SEA

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The U.S. Marine Corps concept for the projection of naval power ashore is Operational Maneuver from the Sea (OMFTS). OMFTS calls for movement of Marines from ships at sea directly to objectives deep inland without requiring a pause to build-up combat power on the beach. Support for ground forces is expected to come from the sea and be delivered primarily by air. This demands that sea-based logistics assets remain sufficiently close to shore to allow air assets to conduct resupply operations directly to the battlefield. The implication of this is that Navy ships may sacrifice operational and perhaps tactical mobility while sustaining the Marine operation.

This thesis determines the distance from the coastline sea-based Combat Service Support (CSS) assets will be able to maintain and still support operations of a given magnitude, and how tactically constrained Navy ships will be in order to support this concept of expeditionary warfare. It focuses on the time-distance-weight/volume relationships involved, and takes into account characteristics of the resupply assets, such as aircraft availability, capacity, method of employment, and the effects of combat attrition. Three methods of employing a Marine Expeditionary Unit are studied, ranging from a traditional force mix to the use of small infestation teams. The analysis shows that the available CSS assets will not support a traditional ground force mix at the distances envisioned, but will support the use of small teams. To fully realize OMFTS and still allow ships to maintain the desired standoff from shore will require a shift to more lethal Marine forces with much smaller logistical demands. Until such a force is feasible, the Navy should plan on providing support to Marines from close to shore.

MODELING DATA ENCAPSULATION AND A COMMUNICATION NETWORK FOR THE NATIONAL TRAINING CENTER, FORT IRWIN, CA

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The National Training Center (NTC) located at Fort Irwin, California provides the U.S. Army sole replication of a desert combat environment. The NTC provides U.S. Army brigade size heavy forces both realistic training scenarios and an accurate record of mission execution. The primary emphasis of this research is to develop the methodology for modeling both data encapsulation and transmission via a fiber optic cable for the NTC. To capitalize on technological advances, the NTC requires a relational database for data encapsulation. The database structure in this effort efficiently stores Range Data Management System (RDMS) and Observer/Controller (OC) data input. The NTC also requires a mathematical modeling (network) tool with the capability of flexible analysis of a modular fiber optic cable system. The NTC Route Optimizer program developed in this effort provides a tool for rapid manipulation of design factors with immediate graphical and numerical feedback. Additionally, the reader is given methods to design future upgrades to the database and change specifications of the fiber optic cable system. This allows the reader to manipulate technology for specific goals instead of receiving transparent improvements that are disconnected.

OPTIMALLY FUNDING ARMY INSTALLATION REPAIR AND MAINTENANCE ACTIVITIES

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The Army's Assistant Chief of Staff for Installation Management (ACSIM) allocated over $4862 Billion in 1995 to over 200 Army installations for Repair and Maintenance Activities (RPMA). However, this allocation and those of the recent past have historically covered only 40 to 70 percent of total requirements. In response, ACSIM developed an efficient and defensible management paradigm called Infrastructure Decision Architecture (IDA). The IDA contains a model called the Decision Support Tool (DST) that projects future infrastructure status given a proposed six-year budget, the current infrastructure status, a funding hierarchy, and an infrastructure priority. This thesis develops a linear program incorporating the goals of the IDA into an optimization-based decision support system, completing the DST. This thesis affords ACSIM decision makers the following abilities: a projection of the optimal inventory status resulting from a given budget; the six year annual allocation policy to obtain the optimal benefit; the ability to defend budget needs concerning desired infrastructure status in the procurement cycle; and the ability to conduct "what ifs" on different budget strategies and infrastructure end states. Successful model runs for eleven different major commands using fiscal year 1996 data resulted in installation infrastructure status projections and annual funding consistent with ACSIM priorities.

THE COMMAND AND CONTROL OF SPECIAL OPERATIONS FORCES
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The operations chosen in this work are short duration, direct action missions in either semi-permissive or non-permissive environments at either the operational or strategic levels of war or in operations other than war (OOTW). Specifically, this thesis will examine SOF participation in Desert One, Grenada (Urgent Fury), Panama (Just Cause), and Somalia to determine the effectiveness of C2. Emphasis will be placed on two integrated areas of the principles of war—unity of command and simplicity. Unity of command is looked at with regard to impartiality toward the needs and capabilities of all forces represented. Simplicity is concerned with overly complicated plans and their deconfliction. Both unity of command and simplicity illustrate possible ways to improve the planning and execution of future operations.

In a previous work on integrated operations, Michael Kershaw acknowledges the relationship between command and training and a special unit's ability to integrate with general purpose forces (GPF). He does limit his analysis to the development of a theory of integrated operations. The relation of command and its significance on shaping a mission's success is discussed. This thesis will conclude with a judgment on SOCOM's effectiveness and some possible future implications.

OPTIMIZING ORDNANCE LOADOUT OF NAVY SURFACE COMBATANTS OPERATING IN SUPPORT OF NAVAL SURFACE FIRE SUPPORT
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This thesis develops a model to assist in determining the optimal surface combatant loadout of surface-to-surface ordnance while in the performance of Naval Surface Fire Support. Through simple mathematical modeling using a spreadsheet, the number of rounds of ordnance are calculated along with the number of ships required to deliver the ordnance. The results are based on the user's engagement doctrine and knowledge of the enemy's disposition and strength. The model attempts to minimize the overall costs of both ordnance and delivery ships to provide a solution that defeats all engagable targets.

A SURVIVAL ANALYSIS OF THE TANKS AND VOIDS ON *USS JOHN F. KENNEDY* (CV 67) AND *USS ENTERPRISE* (CVN 65)
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The maintenance of an aircraft carrier's tanks and voids has a direct impact on the ship operability and service life. The scheduling of inspections and repair work for these tanks and voids poses a significant problem for the carrier maintenance community. This thesis contributes to refining strategy in the repair planning process by providing the framework for building comprehensive tank and void database files. To demonstrate this, repair history files are constructed for *USS John F. Kennedy* (CV 67) and *USS Enterprise* (CVN 65). These files consolidate tank and void repair documentation from the myriad of carrier maintenance agencies and comprise the most complete database for these ships. A similar database can be developed for all the carriers by duplicating this effort. A life cycle analysis of the data reveals that paint coating failure rates

are more similar among tanks and voids on the same ship rather than among tanks of the same functional type. A case study for CV-67 examines model accuracy and predicts the expected number of coating failures at a future maintenance period. The lessons learned in this thesis directly supports a follow on study of the JP-5 tanks on the Nimitz class aircraft carriers.

CLASSIFICATION, SEARCH, AND RETRIEVAL IN A MULTI-VARIABLE, MULTI-LEVEL TAXONOMY: APPLICATION TO DECISIONNET
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The explosion of information available on global computer networks underlines the need for effective repositories that facilitate organization of, and search for, information. These digital repositories may contain simple data, or increasingly, objects of other types such as software and decision models. A taxonomy can be thought of as a navigational aid to a repository. Organization of objects may take place along multiple dimensions, each of which may have a taxonomy of classification terms that spans many levels.

This thesis examines the design and development of a WWW based Classification, Registration, Search, and Retrieval System. The system was applied and tested on the DecisionNet project which is an electronic brokerage house for decision technologies. In order to facilitate user interaction via the WWW the system was designed to be run through a standard web browser. A graphical user interface was developed in Java. The back-end functions for data management, search and retrieval were also programmed largely in Java.

DEVELOPING A STANDARD UNIT-LEVEL OBJECT MODEL
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This thesis describes the development of a standard unit-level object model for combat simulations. This thesis is part of an Army Modeling and Simulation Office (AMSO) sponsored study examining selected models from existing and future simulations in order to provide examples and insights to support object standards development. Object models are a key feature of the Department of Defense (DoD) High Level Architecture (HLA) and the Defense Modeling and Simulation Office (DMSO) Conceptual Model of the Mission Space (CMMS). Developing standard objects helps promote consistency among Army combat models and foster both interoperability and model reuse.

As a basis for developing a standard unit-level object model, three legacy and two developmental simulation models were studied. The set of common attributes and methods from the object models of Modular Semi-Automated Forces (ModSAF), Integrated Theater Engagement Model (ITEM), Eagle, WARSIM 2000, and Joint Warfare System (JWARS) were examined for common attributes and behaviors.

The standard unit-level object model and its components were based on the core competencies of military units: planning, communicating, command and control, shooting, movement, and sustainment. This model achieves interoperability by establishing a minimum/essential set of components, attributes, and methods. Finally reuse is maximized through polymorphic component-based design.

EXPLORING A CHROMATIC OBLIQUE EFFECT

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For centuries, military forces have used camouflage to obscure potential targets from the enemy. Because the eye is fairly adept at picking out edges, colors, and bright areas, camouflage is often used to degrade these qualities from human detection. The purpose of this thesis was to investigate the role of certain spatial, temporal, and chromatic features on the human visual system and how these features may aid the quest for better camouflage. Methods: Test patterns were spatio-temporal raised cosines of varying orientation (horizontal or vertical and oblique), spatial frequency (1, 3, and 7 cpd), and modulated at 2.0 Hz. Color contrast thresholds were determined from 16 different red-green color mixture ratios. This methodology eliminates the problems with luminance artifacts and the need to determine exact equiluminance.

Results: The data formed an ellipse with the half-length measuring color discrimination and the half-width measuring brightness discrimination. A maximum likelihood method was used to fit the data. Three of the four subjects showed a 3 cpd chromatic oblique effect, while the 1 and 7 cpd achromatic and chromatic oblique effect was inconsistent across subjects. Conclusions: While real-world objects are more complex than laboratory stimuli, knowledge of spatial and chromatic qualities that inhibit detection will aid the quest for better camouflage.

EFFICIENTLY INTERDICTING A TIME-EXPANDED TRANSSHIPMENT NETWORK

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A “network interdictor” has a limited supply of resource with which to disrupt a “network user’s” flow of supplies in a capacitated transshipment network. The interdictor’s problem of minimizing the maximum flow through the network is a difficult-to-solve integer-programming problem but it is shown that a heuristic based on Lagrangian relaxation is very effective in approximately solving the problem.

Algorithms in C are implemented to approximately solve both the static (without considering time) and dynamic network interdiction problems. Static test networks range in size from 25 nodes and 64 arcs to 400 nodes and 15 19 arcs. Using a TBM RS/6000 Model 590 workstation, optimal solutions were found for 7 of 12 test networks and solve the largest problem in only 31.0 seconds. A dynamic network was modeled in time-expanded form in order to assign time weights of 0 or 1 to flow, include repair time of interdicted arcs, and provide a schedule to the network interdictor that identifies arcs and time periods for interdictions. Dynamic networks range in size from 500 nodes and 3,200 arcs to 40,000 nodes and 151,900 arcs (in time-expanded form). Near-optimal solutions were found in 13 of 24 test networks and solve the largest network in 1729.5 seconds.

A METHODOLOGY FOR COMPREHENSIVE QUANTITATIVE EVALUATION OF A COMPUTER-AIDED EXERCISE USING THE JOINT THEATER LEVEL SIMULATION (JTLS)

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The CJCS Joint Training Program institutes methods for identifying training requirements through review of the CINCs' missions and the compilation of Joint Mission Essential Task Lists (JMETLs). The Universal Joint Task List (UJTL) comprehensively outlines these joint essential tasks, providing a summary of CINC Missions, Joint Tasks, and supporting tasks.

Computer-aided exercises (CAXs) are tools available for monitoring and training staffs in these tasks. A primary goal during a CAX is to present a realistic decision environment to the training audience in order to produce realistic results. This thesis develops an analysis methodology for using exercise data to evaluate critical event causal audit trails. Specific objectives are: 1) to develop methodologies to objectively analyze the causes for critical events, and 2) to demonstrate the effectiveness of these methodologies through the use of the Joint Theater Level Simulator (JTLS).

This thesis develops post-exercise analysis techniques for output data and provides a methodology for extracting appropriate data from a CAX. The results of a given CAX will then be more compatible with additional analysis techniques, such as trend analysis, and more useful and timely feedback can be provided to participants.

DEVELOPING A STANDARD PLATFORM-LEVEL ARMY OBJECT MODEL

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Before 1990, the Department of Defense (DoD) modeling and simulation effort was fragmented and uncoordinated. Developers of new simulations usually had to start from scratch and could reuse very few of the components from legacy models. Simulations from different developers were incompatible and inconsistent. One of the features of object-oriented programming (OOP) is the prospect of reusing design and code on future projects. However, reuse does not simply happen, it must be planned by thinking beyond the immediate application and developing a more general design.

Interoperability and reuse are limited because DoD lacks a common technical framework for simulation architecture. The Army Modeling and Simulation Office (AMSO) Master Plan's primary objective is the creation of this framework. Central to the plan is the development of a standard army object model. This thesis documents the development of the initial version of the standard army object model. The role of the standard army object model is to enhance interoperability and reuse and to achieve a minimal level of uniformity in Army simulations. This standard will specify object-oriented properties for classes, and class hierarchies for use with future high-resolution simulation development.

A modified version of Rumbaugh's Object Modeling Technique was used to develop the object model. A component-based design was adopted. The object model is code independent and minimal in design to allow developers maximum flexibility. The research indicates that the standard army object model can also serve as a focal point for other initiatives outlined in the AMSO Master Plan.

ANALYSIS OF THE EFFECTS OF DYNAMIC CHARACTERISTIC DIMENSION CALCULATIONS ON FLIR PERFORMANCE PREDICTION MODELS

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The ability to accurately predict the performance of FLIR systems has become critical to today's military. The current U.S. defense industry standard FLIR analysis model is FLIR92 by the U.S. Army's C2NVEO. The algorithm in FLIR92 for calculating target acquisition probabilities, called ACQUIRE, has several limitations in its design for calculating a target's characteristic dimension.

This thesis develops a dynamic model to overcome these limitations. It incorporates a three dimensional view of a target based on range, azimuth angle to target, and the altitude of the FLIR sensor. An analysis of the effects of dynamically calculating a target's characteristic dimension by the dynamic model and the static ACQUIRE version 1 model is presented. Both are compared on a theoretical target from three different angles: the front, the 45, and the side, with the dynamic model producing an 8% increase in prediction ranges for the front, a 4% increase for the 450 view, and a 5% increase for the side. An empirical cumulative tail distribution is computed from experimental data, and the theoretical probability versus range predictions of each model are then compared to actual observations. A sensitivity analysis is performed to demonstrate the effects of various conditions on predicted acquisition ranges.

AN ANALYSIS OF ADVERTISING EFFECTIVENESS FOR U.S. NAVY RECRUITING

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This thesis estimates the effect of Navy television advertising on enlistment rates of high quality male recruits (Armed Forces Qualification Test (AFQT) score of 50 or higher and a high school diploma). Additionally, the effects of Navy radio, Navy journal, Navy direct mail, Joint television (Joint advertising is for all Armed Forces), Joint journal, and Joint direct mail advertising are explored. Enlistment's are modeled as a function of several factors including advertising, recruiters, and economic. Regression analyses (Ordinary Least Squares and Two-Stage Least Squares) explore the relationship between male high quality contracts and various advertising and economic factors. Results indicate that Navy television advertising, Navy direct mail advertising, Navy radio advertising, Joint television advertising and Joint direct mail advertising have a significant impact on recruiting performance over time and across recruiting districts.

TACTICAL MODEL OF HYPERSPECTRAL IMAGERY IN SUPPORT OF THEATER BALLISTIC MISSILE DEFENSE

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This thesis presents techniques for simulating hyperspectral imagery (HSI) in an effort to counter the threat of mobile theater ballistic missiles. Using Predator and Global Hawk Unmanned Aerial Vehicles (UAVs) as air platforms for the spectral imagers, this study presents a stochastic model of a search and destroy mission using the Sensor Search/Precision Strike (SS/PS) simulation model. A fractional factorial design was utilized to study six variables: the different UAVs conducting the search, the number of bands selected for the spectral imagers, the number of killer assets available for targeting

the transporter erector launchers (TELs), the uncamouflaged time spent by the TELs, the number of TELs in the area of operation, and the number of decoys used by the enemy. In addition, two different scenarios were modeled using the cueing assets from HSI-mounted tactical satellites in one and cueing with an HSI-mounted Global Hawk UAV in the other. The simulation model used a detection and identification probability database derived from recently published field tests and makes key assumptions about future HSI detection capabilities. This thesis explains numerous interactions between the variables listed above and provides insight on tradeoffs with UAV and sensor settings. Although simplifying assumptions and drastically reduced false detection rates help improve the sensors' results, the findings indicate a greater success from cueing by satellite and from using a higher UAV with more spectral bands.

THE COST AND BENEFITS OF REDUCED MANNING FOR U.S. NAVAL COMBATANTS
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The increasing cost of manpower in the United States Navy has generated a new initiative identified as Smart Ship. Smart Ship, or the uses of technology for manpower reduction, challenges the culture, tradition, and policies of the Navy. The life cycle cost for surface combatants can be reduced following the guidelines of Smart Ship. However, limited analysis has been conducted into the material readiness cost associated with reduced manning. It was the goal of this thesis to concentrate on the cost and benefits of Smart Ship. A maximum savings of 0.54 percent of the total budget for the Department of the Navy is possible, using FY 1996 dollars. Through analysis conducted in the study, the current objective of reducing manpower costs has been determined to be risky and imprudent. Nevertheless, the United States Navy should pursue Smart Ship to enhance combat effectiveness and quality of life, thereby increasing fleet readiness, morale, productivity, and retention. These factors will far outweigh any dollar savings from Smart Ship.

OPTIMIZING AEROBOT EXPLORATION OF VENUS
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Venus Flyer Robot (VFR) is an aerobot—an autonomous balloon probe—designed for remote exploration of Earth's sister planet in 2003. VFR's simple navigation and control system permits travel to virtually any location on Venus, but it can survive for only a limited duration in the harsh Venusian environment. To help address this limitation, the following was developed: (1) a global circulation model that captures the most important characteristics of the Veunsian atmosphere; (2) a simple aerobot model that captures thermal restrictions faced by VFR at Venus; and (3) one exact and two heuristic algorithms that, using abstractions (1) and (2), construct routes making the best use of VFR's limited lifetime. This modeling was demostrated by planning several small example missions and a prototypical mission that explored numerous interesting sites recently documented in the planetary geology literature.

REDUCTION OF A LARGE-SCALE GLOBAL MOBILITY OPTIMIZATION MODEL THROUGH AGGREGATION
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This thesis develops a two-stage aggregation/ disaggregation model based on THRUPUT2 (Morton, Rosenthal and Lim, 1995), a mobility optimization model used to analyze the ability of the Armed Forces of the United States to conduct airlifts in support of major military operations. For a given fleet of aircraft, a given network of routes, and a given set of unit movement requirements over time, THRUPUT2 schedules airlift to minimize late deliveries and non-deliveries. The model presented is based on THRUPUT2, but aggregates those units that share the same origin-destination pair and have overlapping time periods and therefore creates a smaller linear program. This reduction in size will consequently decrease the time needed to solve, which is desirable because repeated runs of this model are necessary to generate analytic insight and develop recommendations. The thesis further develops a disaggregation model which will remove the aggregations of the first, and therefore offer resolution similar to that of THRUPUT2.

MODELING THE COMBAT POWER POTENTIAL OF MARINE CORPS CLOSE AIR SUPPORT
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This thesis proposes a numerical measure of the combat power potential of U.S. Marine Corps close air support (CAS) aircraft. The combat power potential of a weapon system is defined as the rate at which the system could deliver lethal fire to any point on the battlefield, accounting for particular and relevant battlefield and enemy characteristics. This measure is expressed in units of "kills-per-minute," where each point is hypothesized to have an infinite supply of instantaneously replaced targets.

The collection of these values (i.e., kills-per-minute for each battlefield point) is suitable for display as a "combat potential surface," overlaid on a battlefield map. In this thesis, points of higher potential are keyed to brighter colors (e.g., red, yellow, orange). The end result is a battlefield visualization tool to assist commanders and staffs in CAS planning.

ALLOCATION OF NAVY REAL PROPERTY MAINTENANCE FUNDING
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The Office of the Chief of Naval Operations (OPNAV) allocates roughly $900 million annually from its operations and maintenance (O&M) appropriation for facilities maintenance and repair. Annual reports of facility condition, plant value, and maintenance and repair costs provide the basis for apportionment of these funds to each of 15 major Naval organizations (major claimants). Funding shortfalls have contributed to a chronic deferral of maintenance and repair projects. The resulting backlog of critical unfunded requirements for facilities maintained by the O&M appropriation totaled $2 billion at the end of fiscal year 1995. OPNAV's objective is to stabilize or reduce this backlog over time while providing maintenance

and repair funding for the major claimants consistent with readiness objectives. This thesis develops a multi-objective, infinite horizon linear program to determine multi-year maintenance and repair funding levels for the major claimants while adhering to annual budget constraints and a standard Navy facility priority system linked to operational readiness. The model produces funding recommendations that are managerially and administratively feasible, and it shows an improved capacity to apportion funding consistently with the existing priority system.

LOGISTICS MODEL DESIGN IN MILITARY OPERATIONS OTHER THAN WAR/FULL SPECTRUM OPERATIONS

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Quantification of logistics requirements is essential to providing modeling and simulation with adequate logistics capability. Current models and simulations often rely on operator interface to accomplish the prioritization of logistics resources. However, this study shows that logistics requirements can be quantified based on the dimensions: Phase of the Operation, Level of Planning, Level of Support, and the Full Spectrum of Operations (FSO).

Believing differences exist in logistics priorities as these dimensions change, an experiment in survey form was given to logistics personnel in military commands as well as civilian relief agencies that have been involved in three types of Peace Operations: Humanitarian Assistance, Humanitarian Assistance/Disaster Relief, and Noncombatant Evacuation Operations. The goal was to derive a measure of the relative importance of particular logistics supplies or services in these Operations Other Than War (OOTW). The Method of Equal Appearing Intervals (MEAI) was applied to derive the measure of relative importance.

The analytical results show that as factors change in the operation, there is a change in the relative importance of logistics classes. In addition, as the operations change, there are a different set of priorities associated with each mission. The MEAI measurements can be applied directly in decision aids or in modeling and simulation efforts involving OOTW. The recommendations are to expand this approach by refining the survey and expanding the operations to include FSO.

OPERATIONALLY - RELEVANT TEST LENGTHS: A DECISION - ANALYSIS APPROACH

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This thesis approaches the question of “How much testing is enough?” by formulating a model for the combat situation in which the weapon (e.g., missile) will be used. Methods of Bayesian statistics are employed to allow the decision-maker to benefit from prior information gained in the testing of similar systems by forecasting the operational gain from acceptance. A Microsoft Excel 97.0 spreadsheet serves as the user interface, and Visual Basic for Applications, Excel’s built in macro-language, is the language used to produce the source code. The methodology accommodates two different tactical usages for the missile: a single shot, or a salvo of two shots. The missile might be acceptable if used in the two-shot salvo mode, but not in the single shot mode, and this would imply a greater cost per mission. In the end the missile might not be judged cost-effective as compared to a competitive system. If the model proposed is (or can become) adequate much can be calculated/estimated before any operational tests are made. This could assist in economizing on operational testing.

TRAINING ASSESSMENT AND MODELING SUBJECTIVE DATA ENCAPSULATION FOR THE NATIONAL TRAINING CENTER
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The National Training Center (NTC) located at Fort Irwin, California performs the critical Army mission of preparing battalion task forces and brigade staffs for combat. The NTC provides a unique opportunity to assess training proficiency. To assist in the training assessment of rotating units, the Army has spent millions of dollars on a state of the art instrumentation system that transmits objective data from all player vehicles and stores the information in a database. Currently, no subjective observer-controller (O/C) observations of training are stored in the database. The primary emphasis of this research is to develop a training assessment system and model subjective data encapsulation to enhance training performance analysis. The assessment system is designed to be incorporated into a relational database that will allow analysis of various measures of performance that provide input for platoon through brigade level After Action Reviews (AAR). Additionally, the database will support methods for simple data manipulation for the purpose of conducting post-rotation analysis and the identification of trends.

NAVY ENLISTMENT: AN ANALYSIS OF MILITARY ENTRANCE PROCESSING STATIONS' MEDICAL FAILURES
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In a given month up to 20% of the applicants sent to a Military Entrance Processing Station (MEPS) by a recruiter do not enlist in the Navy. There are many reasons for these failures and they represent an expense. The thesis concerns medical failures, which can account for up to half of those applicant losses. Its objective centers on the analysis of the medical disqualifications that occurred at the MEPS. This analysis is broken into two main areas. The first is to differentiate between those Navy applicants who failed and those who did not fail to enter service on medical grounds. The second is to differentiate between those applicant characteristics which have stronger or weaker relationships toward weight failures, which represent the most common medical failure. To achieve these objectives the analysis focuses on all Department of Defense recruits who screened for service in the United States Navy during Fiscal Year 1995. The important factors, revealed by the analysis, are the main effects such as sex, race, age etc. Significant differences between the levels of a factor can be discovered when comparing the individual MEPS regions. Through this analysis a snapshot of applicant characteristics and medical failures is provided. It may aid Navy recruiting policy makers to revise applicant medical policies and procedures.

COMPARING THE MAXIMUM LIKELIHOOD METHOD AND A MODIFIED MOMENT METHOD TO FIT A WEIBULL DISTRIBUTION TO AIRCRAFT ENGINE FAILURE TIME DATA
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This thesis provides a comparison of the accuracies of two methods for fitting a Weibull distribution to a set of aircraft engines time-between-failure data.

One method used is the Maximum Likelihood Method and assumes that these engine failure times are independent. The other method is a Modified Method of Moments procedure and uses the fact that if time to failure T has a Weibull distribution with scale parameter l and shape parameter ß, then $T^{ß}$ has an exponential distribution with scale parameter $l^{ß}$. The latter method makes no assumption about independent failure times.

A comparison is made from times that are randomly generated with a program. The program generates times in a manner that resembles the way in which engine failures occur in the real world for an engine with three subsystems. These generated operating times between failures for the same engine are not statistically independent. This comparison was extended to real data.

Although the two methods gave good fits, the Maximum Likelihood Method produced a better fit than the Modified Method of Moments. Explanations for this fact are analyzed and presented in the conclusions.

ANALYSES OF UNATTENDED GROUND SENSORS IN THEATER MISSILE DEFENSE ATTACK OPERATIONS
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Unattended ground sensors have a tremendous potential for improving Tactical Ballistic Missile Attack Operations. To date, however, this potential has gone unrealized primarily due to a lack of confidence in the systems and a lack of tactical doctrine for their employment. This thesis provides analyses to demonstrate the effective use of sensor technology and provides recommendations as to how they may best be employed.

The probabilistic decision model reports the optimal size array for each of the candidate array locations. It also provides an optimal policy for determining the likelihood that the target is a Time Critical Target based on the number of sensors in agreement as to its identity. This policy may vary with each candidate array. Additionally, recommendations are made on the placement of the arrays within the theater of operations and their optimal configuration to maximize information gained while minimizing the likelihood of compromise. Specifics include, inter-sensor spacing, placement patterns, array locations, and off-road distance.

THE BATTLE GROUP LOGISTICS COMPARATIVE ANALYSIS MODEL (BGLCAM): A COMPARATIVE ANALYSIS TOOL FOR MULTI-BATTLE GROUP LOGISTICS SUPPORT
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This thesis develops a computer simulation for modeling the logistical support of multiple naval battle groups in a peacetime or wartime setting. The simulation model, written in Microsoft Visual Basic Version 5.0, allows the user to create any number of naval battle groups containing multiple combatants that are located by latitude and longitude. Each battle group operates with one or two assigned station supply ships, i.e., a fast combat support (AOE) ship, or a fleet oiler (AO) ship and ammunition (AE) ship, respectively. Additionally, the user can create any number of Forward Logistics Base (FLB) ports and Continental United States (CONUS) ports, each having any number and type of shuttle supply ships assigned to them. Every ship and port has four major supply categories: F44 (aviation fuel), F76 (diesel fuel marine), ammunitions, and stores. The combatant's supplies are consumed over the specified time frame based on a randomly selected F76 rate, a fixed user-inputted stores rate and, if desired, multiple user-inputted F44 and ammunition rates. The multiple user-inputted F44 and ammunition consumption rates capability enables the user to model a naval battle based on any previously developed Tactical Warfare (TAC WAR) or similar scenario involving aircraft carrier and/or amphibious battle groups.

TRICARE VERSUS FEDERAL EMPLOYEES HEALTH BENEFITS PROGRAM: A PILOT STUDY OF COMPARATIVE INPATIENT COSTS IN REGION 10

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Approximately 3.5 billion dollars of the Defense Budget for Fiscal Year 1997 was allocated for the care of non-active duty beneficiaries. This thesis is a pilot study exploring one option to restructure the military beneficiary health system. Two methods of health care delivery are examined: traditional fee-for-service plans, and health maintenance organizations (HMO). The advantages, disadvantages, and cost implications associated with inpatient care, in TRICARE Region 10, under the TRICARE Program and the Federal Employees Health Benefits Program are explored, using some recent historical data. The FEHBP fee-for-service costs were found to be higher than TRICARE standard costs. It is inferred that allowing non-active duty military beneficiaries to participate in the HMO option of the FEHBP reduces out-of-pocket inpatient cost to the enrollee and maintains or improves access to and quality of care. Costs to the government for inpatient care are reduced. Four cases are examined, determining out-of-pocket enrollee cost as well as savings to the government. Lastly, a Health care Demands and cost Probability Model is developed; the model generalizes and is consistent with assumptions made for previous calculation and could be adapted to determine outpatient costs as well. It allows government estimates of random variations in health care costs to be made.

SPECIAL OPERATIONS INTEGRATION IN THEATER MISSILE DEFENSE

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During Desert Storm, one of the threats U.S. forces faced was from Iraqi ballistic missiles. The threat of the ballistic missiles deploying with weapons of mass destruction, coupled with the political ramifications of the missiles launched into Israel, made targeting the transporter erector launchers (TELs) a top priority for coalition forces. Few forces were successful in detecting and targeting the TELs. Units that reportedly had success were British and American Special Operations Forces. This suggests that while U.S. overhead intelligence, surveillance and reconnaissance systems provide critical intelligence of the enemy situation, there is still an active role for Special Operations in ground reconnaissance.

Currently, the services are developing an intelligence and communication architecture to provide better battlefield awareness. One of the goals of this architecture is to reduce the time necessary to target enemy forces. Special Operations Forces can utilize this developing communication architecture to improve their role in Theater Missile Defense attack operations.

This thesis develops two concepts of operation for locating TELs. The first is a network interdiction operation, and the second is an area search. Each may be appropriate to the Joint Force Commander under specific circumstances. The network interdiction operation is modeled as a two-person zero-sum game **CRISIS.**

ANALYSIS OF ADVANCEMENT AND ATTRITION IN THE MILITARY CEREMONIAL UNITS
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The Navy's Ceremonial Guard, the Air Force Honor Guard, the Army's Old Guard, and the Marine Barracks, Washington are specially dedicated units that provide ceremonial personnel for official functions including funeral details, foreign dignitary arrivals, color guards, and drill teams. The majority of the members are volunteers selected from recruit training or the immediate follow-on training to begin a two to three year tour with the appropriate ceremonial unit while putting their normal career progression on hold.

Information on individuals who entered the military service during fiscal years 1986 to 1995 and were assigned to one of the ceremonial units was collected. The distribution of the time required to advance from paygrade E3 to E4, from E4 to ES and from ES to E6 as well as attrition (voluntary or involuntary) from the same paygrades for the ceremonial members was compared to the same information from service specific comparative random samples. The analysis seeks and details any effects on a service member's career for time spent with a ceremonial unit. The most conspicuous conclusion was that Navy Ceremonial Guard members in paygrade E3 had a higher attrition rate, a lower advancement rate and took longer to attain their advancements to paygrade E4 than did their random sample counterparts. Affects for other service and paygrade combinations appear relatively insignificant.

A NONLINEAR OPTIMIZATION FOR PLANNING PROCUREMENT AND USE OF AIRCRAFT AND AIR-DROPPED MUNITIONS, AND FOR ALLOCATING AIR DEFENSE SUPPRESSION: THE ENHANCED STRIKE MODEL
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The United States Air Force (USAF) spends several billion dollars every year on conventional (non-nuclear) air-dropped munitions and the aircraft used to deliver them. USAF munitions planners have long used a series of optimization-based decision support systems to evaluate theater plans, reconcile conflicting needs, and justify budget requests. This thesis proposes the ENHANCED STRIKE MODEL (ESM) as the next model in this evolution. ESM uses existing data and prescribes plans with the same high fidelity and in the same format as its most modem predecessor, the Conventional Forces Assessment Model (CFAM). But, ESM offers critical new features: suppression of enemy air defenses (SEAD) and jamming efforts are explicitly modeled for the first time, enabling evaluation of tradeoffs among stealth, defense suppression, and standoff.

OPTIMALLY REORGANIZING NAVY SHORE INFRASTRUCTURE
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The end of the cold war has allowed the United States to significantly reduce defense spending. Spending has been reduced for both the force structure (i.e., equipment and manpower) and the military support base (i.e., infrastructure), but infra-

structure reductions continue to lag force structure reductions. The United States Navy's recent initiatives to reduce its shore infrastructure costs include "regionalization," "outsourcing," and "homebasing." While regionalization and outsourcing decrease the number of jobs needed on a shore installation, homebasing generally increases the number of available personnel. These opposing effects require careful implementation. This thesis develops the Regionalization and Outsourcing Optimization Model (ROOM), an integer linear program that identifies an optimal combination of regionalization and outsourcing options for a Navy shore installation with personnel altered by homebasing. A ROOM test case uses actual data from the Pearl Harbor Naval Installation with proposed homebasing and regionalization and outsourcing options for 109 "functions," or shore installation activities. Disregarding homebasing and its opposing effects, regionalization is the lowest cost option for 106 of these functions. ROOM's optimal solution, however, recommends regionalizing only 21 functions, outsourcing 14, and leaving 74 unchanged. This solution yields a first-year savings of $9.5 million.

AN EVALUATION OF THE BUDGET AND READINESS IMPACTS OF BATTLEGROUP SPARING

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Battlegroup sparing is an inventory strategy that can significantly reduce the initial outfitting costs of a weapon system by greatly reducing the range and depth of spares required to outfit individual ships. This strategy moves low demand items from shipboard spare part inventories to intermediate level inventories which support an entire battlegroup. This thesis extends the techniques of Readiness Based Sparing (RBS) and proposes a method for defining suites of spares at both the shipboard and battlegroup level which augment each other to achieve a desired level of readiness while realizing the efficiencies of battlegroup sparing. To evaluate the impacts of this strategy, this thesis develops a computer simulation, which can be utilized to evaluate the budget and readiness impacts of applying this or any other inventory strategy to a weapon system. The methodology proposed by this thesis was then applied to the Cooperative Engagement System reducing initial outfitting costs by nearly 50%, an overall savings of over thirty-three million dollars in scarce outfitting funds.

VALIDATION OF THE TIME STRIKE OPTIMIZATION MODEL THROUGH SIMULATION

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The TIME STRIKE optimization model was developed in 1995 for use by the cognizant U.S. Air Force agencies to investigate requirements for conventional munitions and the feasibility of operational plans based on their availability and current budgets. The problem addressed here is: Is the output of TIME STRIKE accurate when compared to a simulation? This thesis develops a computer simulation, called SimStrike, which models all the same things TIME STRIKE does, using the same data, however with randomness used where TIME STRIKE uses expectations. It was found that TIME STRIKE and SimStrike produce similar results.

FORM ASSEMBLY FOR THE ARMED SERVICES VOCATIONAL APTITUDE BATTERY (AS VAB) - AN OPTIMAL AND A HEURISTIC APPROACH

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The 1948 Selective Service Act established a process whereby all United States (U.S.) military applicants take an aptitude test to measure their suitability for military job specialties. The latest version of these tests, the Armed Services Vocational Aptitude Battery (AS VAB), was introduced in 1968. Approximately 900,000 high school students from 14,000 U.S. high schools take the ASVAB test each year. This "paper and pencil" test requires the applicant to answer multiple choice questions (items) on a printed form. The creation of paper and pencil forms in one of the ten test topics is called form assembly. Form assembly consists of picking 20 to 35 items from an item pool of about 300 items such that: 1) each item appears on at most one form; 2) each form's result represents the applicant's capability; and 3) each form has the same level of difficulty. The thesis models the creation of paper and pencil forms as a mixed integer linear goal program and solves the problem both optimally and heuristically. Computational results for seven ASVAB-Tests show both methods help improve the form assembly process.

OPTIMIZING ANTI-SUBMARINE WARFARE SEARCH FOR HIGH VALUE UNIT (HVU) PROTECTION USING THE FORWARD AND BACKWARD (FAB) ALGORITHM

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This thesis researches the feasibility of a TDA (tactical decision aid) to defend a high value surface unit from an enemy submarine. Accordingly, this research adopts a FAB (forward and backward) algorithm to search for a moving target. It develops a prototype of a TDA: FABTDA which gives an optimal allocation of aircraft.

BUILDING AN OBJECT MODEL OF A LEGACY SIMULATION

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The Department of Defense proclamation that all simulations comply with High Level Architecture (HLA) standards prompted the U.S. Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC) to investigate the feasibility of including Janus in future HLA Federations. Janus, one of the Army's most extensively used models, is an stochastic high-resolution simulation. As a procedural legacy model coded prior to the rise of object-oriented programming, there are considerable challenges for Janus to meet HLA requirements.

This thesis proposes a methodology to produce a HLA Simulation Object Model (SOM) for procedurally implemented legacy simulations. The result obtained by using this methodology is a general object model and one or more SOMs. The general object model provides a full object-oriented template of the legacy simulation that is unrestricted by the model's code or the minimum requirement for interoperability. The SOM is derived from the general object model.

This research indicates that procedural legacy simulations can comply with the HLA SOM requirement. In order to achieve this compliance, it is advantageous to first develop the general object model. Additionally, it is important to include an analyst in the SOM development process if federation outputs will be used for analysis.

SOM development facilitated the identification of additional steps necessary to make Janus HLA compliant. This effort will continue with a review of the SOM by Janus code experts and work on a software service that will allow Janus to communicate with other simulations in the HLA specified format.

A STATISTICAL ANALYSIS OF THE U.S. MARINE CORPS LIEUTENANT COLONEL COMMAND SCREENING PROCESS
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In 1992, the U.S. Marine Corps instituted a Command Screening Program (CSP) to annually select the most qualified Lieutenant Colonels (LtCols) to command. Prior to the CSP, the selection of Commanding Officers (COs) was left to the decision of the Commanding Generals. This thesis establishes the methodology, conducted with the current data available, to determine if the CSP is a "better" CO selection process and if there is an overall career advantage for LtCols who command. Fitness report information, without performance markings, was obtained for 3,417 officers. Each officer was placed into one of four mutually exclusive groups, first dependent on whether the officer was a CO as a LtCol or not and second whether retired or promoted prior to June 1, 1993 (the date the CSP took effect) or not. Measures of Effectiveness (MOEs) include the mean duration of a command tour, the proportions promoted, passed over, and voluntarily retired, and the proportion promoted "early, on time, or late." Hypothesis tests are conducted on the pairwise comparison of group proportions for each MOE. The results, based on the MOEs, are somewhat mixed but generally indicate that the CSP is selecting more effective COs, and that there is a career advantage for LtCols who command. The results will be more convincing as the CO group that began command after June 1, 1993 gains more time in service and more time in rank. Currently only 8.9% of this group has voluntarily retired or been in the promotion zone for Col.

RE-ASSIGNING HOMEPORTS FOR UNITED STATES COAST GUARD MEDIUM AND HIGH ENDURANCE CUTTERS
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The Cutter Assignment Model (CAM) is an optimization-based decision aid that recommends relocation of cutters to homeports in order to maximize combined benefits less relocation costs. In 1996, the Chief of Coast Guard Operations identified port assignments of medium and high endurance cutters as an area where the Coast Guard can improve quality of service. A Strategic Homeports Study Team has been formed and has evaluated candidate ports with respect to a variety of criteria, ranging from proximity to mission areas to shore services. The availability and quality of support and services at a port directly influence mission performance. The Coast Guard seeks cutter reassignments to improve those benefits and others associated with clustering like cutters (collocating) while minimizing costs. CAM prescribes optimal assignments for a complete Pacific or Atlantic operating area scenario in a few minutes using commercial software on a personal computer. CAM also accommodates and optimally completes partial restrictions of assignment scenarios to reflect human judgment or some non-quantifiable considerations.

PEROXONE GROUNDWATER TREATMENT OF EXPLOSIVE CONTAMINANTS DEMONSTRATION AND EVALUATION
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The purpose of this thesis is to evaluate the performance and cost effectiveness of a Peroxone Groundwater Treatment Plant (PGTP) designed and operated by Montgomery Watson, in support of the Defense Evaluation Support Agency's independent analysis for the United States Army Environmental Center (USAEC). Many Department of Defense installations have sites that contain groundwater contaminated with explosive materials. Primary methods for the removal of explosive materials involve the use of Granular Activated Carbon (GAC). This process, however, requires additional waste disposal and treatment of explosive laden GAC, thereby incurring additional costs. An alternate method for the treatment of contaminated groundwater involves the use of hydrogen peroxide (H2O2) in conjunction with ozone (03). This method is referred to as the Peroxone oxidation process. A demonstration of the PGTP was conducted from 19 August to 8 November, 1996, at Cornhusker Army Ammunition Plant (CAAP), Grand Island, Nebraska using a small scale version with a maximum flow rate of 25 gallons per minute. The explosive contaminants analyzed during the demonstration include 2,4,6-Trinitrotoluene (TNT), l,3,5-Trinitrobenzene (TNI3), 1,3,5-Triazine (RDX), and Total Nitrobodies. Peroxone cost effectiveness was evaluated using a 30-year life cycle cost comparison to GAC and Ultraviolet/Ozone processes.

ANALYSIS TO SUPPORT HAZARDOUS WASTE MANAGEMENT RE-ENGINEERING AT LAWRENCE LIVERMORE NATIONAL LABORATORY
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This thesis presents an analysis of the current hazardous waste management reengineering project in progress at Lawrence Livermore National Laboratory (LLNL). The primary goal of the re-engineering is to streamline the hazardous waste storage infrastructure through the closure of a large number of existing storage facilities and utilizing a smaller number of "Consolidation" facilities. This goal is accomplished through both waste reduction efforts and early classification of wastes using a Waste Evaluation Form (WEF). Storage need is a function of the amount of waste generated and the time that those wastes remain in storage prior to disposal. Data analysis techniques are used to analyze the quantities of hazardous waste that have been generated at LLNL, as well as the amount of time that these wastes have traditionally remained in on-site storage facilities awaiting disposal. Mathematical and simulation models have been formulated to determine waste storage needs. The results of these models appear reasonable when compared with initial reports from re-engineering efforts being implemented at LLNL, and are used to form recommendations for further re-engineering efforts.

ARSENAL SHIP AUTOMATION AND MANNING ANALYSIS
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The Arsenal Ship concept of operations is unique. The Arsenal Ship provides a remote magazine for other joint warfare systems to utilize, with limited ability to defend itself. Ultimately it resembles a combat logistics ship designed to sail into harm's way ready to provide the initial "punch" as required. Therefore, it should be minimally manned by employing the

most cost-effective technology. With the requirement to reduce crew size, a new approach to manning is required. This thesis provides an alternative approach to manning by identifying the most cost-effective investment in automation commensurate with reducing crew size to the lowest feasible level.

SATISFYING WAR-TIME FUEL REQUIREMENTS WITH A MINIMAL TANKER COMPLEMENT

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The United States Transportation Command (USTC) must ensure that sufficient assets are available to transport the wartime requirements of Petroleum, Oil, and Lubrication (POL) for the military. To be confident that sufficient assets exist to transport POL, USTC must know the number of tankers required. The Mobility Division of the Logistics Directorate of the Joint Staff (J4-MOB) uses a simulation model, the Model for Intertheater Deployment by Air and Sea (MIDAS), to determine the required number of tankers. MIDAS' use is problematic since many runs may be needed, each run is manpower-intensive, and results do not necessarily define the minimum number of tankers. This thesis couples a schedule generator and an integer linear programming (ILP) model to determine the minimum number of tankers to satisfy wartime POL requirements. Solving a realistic scenario provided by J4-MOB (spanning 75 days with 92 available tankers), the ILP selects 19 tankers, one-third the number initially chosen by MIDAS. Using the JLP's recommended schedules, MIDAS confirms the JLP's solution. These results show that the schedule generator and the ILP can assist J4-MOB.

THE DEPENDENCE OF THE SUSTAINABILITY OF NAVAL FORCES ON LOGISTICS INFRASTRUCTURE (U)

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The purpose of this analysis is to determine the extent to which the sustainability of naval forces is dependent on the logistics infrastructure which supports them. To demonstrate the effects of logistics infrastructure on combat sustainability, three scenarios based on the Korean MTW were postulated. The logistics infrastructure was varied in each of the scenarios. Various planning factors were used to estimate the consumption of items in all supply classes by the naval combat forces involved. Analysis was then conducted to determine whether the forces could be sustained in combat given the Combat Logistics Force ships assigned and resources available at the Forward Logistics Site, Advanced Logistics Support Base and in the continental United States. Sustainability was measured in terms of number of days naval forces could not conduct combat operations due to a lack of logistics infrastructure. It was shown that ordnance was the only commodity which constrained combat sustainability. The lack of ordnance ships available and their unbalanced load lists were the major reasons naval forces were not able to sustain combat operations.

DETERMINING OUTSOURCING POTENTIAL FOR THE INVENTORY MANAGEMENT OF NAVY REPAIRABLES

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The potential exists to outsource the inventory management of repairable items to the private sector. However, the Navy must be able to determine when outsourcing will benefit DoD. This research compares Navy inventory management to commercial inventory management in proposed and existing outsourcing programs and develops a model which the NAVICP can use to estimate the potential success for outsourcing repairable items. The research develops an inventory surcharge of 19 percent. The inventory surcharge represents the Navy's costs to perform functions which can be outsourced and serves as a benchmark for comparison to commercial costs. The research then analyzes the costs and benefits of several successful DLA and NAVICP outsourcing initiatives. The analysis results in a model which NAVICP can use to screen repairable items to determine which level of outsourcing will succeed.

A TECHNICAL DEMONSTRATION OF A MAP-BASED LOGISTICS PLANNING TOOL

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The post Cold War is characterized by a wide range of possible military missions, from full scale war to peace keeping missions and by great uncertainty about when and where military response will be required. Military planning systems (for example, logistics, counter-logistics, protection of infrastructure, and infrastructure restoration) must be flexible enough to allow rapid response to situations whose details can not be anticipated. These advanced systems must be able to coordinate resources (maps, overlays, networks, algorithms, models, people) over a distributed network of heterogeneous computers and systems.

This thesis develops a prototype system to demonstrate some of these capabilities. The system loads maps, data files, and algorithms from a computer network and has algorithms to determine optimal ways to disrupt, restore, or protect logistics networks. The planning tool displays the data as an overlay on a map and is user interactive for modification and sensitivity analysis. The system is developed using the Java programming language and thus can be executed without change in a variety of computer environments.

A HIGH RESOLUTION SATELLITE COMMUNICATIONS MODEL

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Information warfare is a cornerstone of Joint Vision 2010 which addresses the future strategic environment for the United States. An integral component of information warfare is the continuing development of joint space doctrine. The Joint Warfare System (JWARS) is a large scale, systemic simulation being developed by the Joint Warfare Systems Office to aid in the evaluation of future joint doctrine and force structure. The purpose of this thesis is to develop and demonstrate Simulation of Satellite Communications (SIMSATCOM), a high resolution, stochastic simulation of satellite communications for evaluating the effectiveness of message transmission and receipt by specified senders and receivers. SIMSATCOM is designed to operate as a stand-alone simulation, but may be adopted as a high-resolution module for a large-scale simu-

lation such as JWARS. The thesis describes SIMSATCOM in detail and provides analyses of simulation runs for different jamming levels and channel capacities.

ANALYSIS AND COMPARISON OF SEVERAL MEASURES OF PERFORMANCE FOR PASSIVE SONAR DETECTION SYSTEMS
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This thesis is motivated by a debate at Commander, Operational Test and Evaluation Force (COTF) concerning which Measure of Performance (MOP) would be best to use when evaluating passive sonar detection systems. COTF has used probability of detection and Figure of Merit in the past, but probability of detection as a function of lateral range is being promoted in a recent Program Executive Officer for Undersea Warfare instruction. This thesis presents a menu of potential MOPs, their definitions, methods for calculating each MOP, relationships that exist between them, and a critique of their strengths and weaknesses as evaluation MOPs. Important MOP attributes are summarized for all listed MOPs to aid in MOP selection. The thesis looks in depth at the relationship between two of these MOPs which could make calculation of the more complex measure somewhat easier. Upper and lower limits for lateral range in terms of cumulative probability of detection are established. As a final step, the thesis involves a critical analysis of an existing computer program, which computes an approximation of a lateral range curve given a list of achieved detection ranges. A recommendation is made concerning use of this program.

A POST-SUBMARINE TENDER ATTACK SUBMARINE ORDNANCE LOGISTICS OPTIMIZATION MODEL AND DECISION-MAKING AID FOR NORFOLK
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Second Reader: Gordon Bradley, Department of Operations Research

For many years the nuclear attack submarines homeported at the Naval Operational Base at Norfolk have relied upon the magazine capability of submarine tenders for local ordnance storage while in port. The last submarine tender will permanently depart Norfolk in 1998 as part of the Navy's downsizing, making the Naval Weapons Station at Yorktown (NWS) the closest torpedo magazine, which is over 40 miles from Norfolk. This shipping distance, coupled with the high cost for day-to-day ordnance handling at NWS (designed only for large ordnance shipments), incurs unacceptable costs for SSN ordnance logistics. The possibility of building a new torpedo magazine in Norfolk is currently being reviewed by CINCLANTFLT his thesis develops a time-step model to analyze the cost effectiveness of developing a magazine to replace the storage capability of the submarine tenders. The model is based on analysis of the frequency of past on-load and off-load demands, and associated costs. This research provides a decision-making aid to CINCLANTFLT Staff, and a model which can be used to assist any cost effectiveness analysis relating to Norfolk SSN in-port ordnance logistics.

EVALUATING COLOR FUSED IMAGE PERFORMANCE ESTIMATORS

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This thesis evaluated the effectiveness of sensor fusion—combining infrared and low-light-level imagery—to improve the F/A-18-target standoff range requirement. Several human performance studies have shown inconsistent results regarding the benefits of color-fused imagery. One method to test the validity of sensor fusion is to use mathematical models that simulate and predict the detection abilities of the human visual system. The mathematical models are derived quantitatively from the image statistics, while the behavior data are a qualitative measure of a human observer. This thesis developed a statistical analysis to compare and contrast these techniques to assess sensor fusion. The four models evaluated were: a Global matched filter, a Local matched filter, a Template matching filter, and a contrast-base image quality metric. Of the four models, the global matched filter produced the highest degree of correlation with the human data. The Global matched filter moderately predicted which of the single-band sensors and which of the fused sensors provided the higher sensitivities despite the characteristically different scenes. Although there are many refinements that need to be explored, the global matched filter concept may be used to evaluate and compare the many different fusion algorithms being proposed.

METHODOLOGY AND DESIGN OF A MULTIMEDIA CD-ROM TAKE HOME PACKAGE FOR THE NATIONAL TRAINING CENTER

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The National Training Center (NTC) located at Fort Irwin, California performs the critical Army mission of preparing battalion task forces and brigade staffs for combat. With a state of the art instrumentation system and full time observer/controllers (OCs), the NTC provides a unique environment where units conduct tough, realistic training and then review performance through comprehensive after action reviews (AARs). At the conclusion of a rotation, the OCs and their staffs coalesce information from the rotation into a Take Home Package (Tim). Unfortunately, the events from the rotation and lessons learned from AARs and the OCs are not effectively incorporated into the TITP. Currently, Take Home Packages are without a standardized format and consist of approximately 300 pages of typed comments with numerous videocassette after action review tapes and supporting graphics. The primary emphasis of this research is to develop a “user friendly” multimedia CD-ROM Tim that provides a clear overview of a unit’s rotation, provides useful observations and supporting data which focus on causes and effects of unit performance, and suggests methods to improve performance through training at home station. The Tim will be easy to produce and presents the objective and subjective data from the newly designed relational database in a logical and easily understood manner. Additionally, the new Tim will support methods for simple data manipulation for the purpose of conducting post-rotation analysis and trend identification.

OPTIMIZING THE NAVY'S TRANSITION TO THE INTEGRATED MAINTENANCE CONCEPT FOR THE H-60 HELICOPTER

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The United States Navy is in the early stages of transitioning to a newly developed maintenance plan for the H-60 helicopter called the Integrated Maintenance Concept (IMC). Before any helicopter can be transitioned to IMC, it must be of a sound structural and material condition, called baseline condition. The Navy's aging fleet of H-60 helicopters needs to be brought up to baseline condition prior to implementation of IMC. There are several alternatives, both existing and proposed, for baselining the fleet before transition to IMC. To aid the Navy during this transition, this thesis develops an optimization model that minimizes the maintenance time required for scheduling the current H-60 inventory during the transition to IMC, ensuring that the entire fleet is of a sound material condition, all operational commitments are met, and all other scheduling requirements are satisfied. To demonstrate its effectiveness, the model is implemented in the General Algebraic Modeling System (GAMS) and produces an optimal timeline schedule of baseline maintenance inductions for each helicopter in the Navy's H-60 inventory.

COMPARISON STUDY OF JANUS AND JLINK

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The Janus simulation model was initially designed to operate in a stand-alone mode. There is an ongoing research project to link Janus to other constructive simulations and virtual simulators. The present standard used to connect different models is Distributed Interactive Simulation (DIS). Janus can operate in a DIS environment using a cell adapter unit called the World Modeler. The combination of Janus and the World Modeler is known as JLink. A goal of the JLink system is to replicate the analytical and training fidelity of stand-alone Janus in a distributed exercise. The purpose of this thesis is to assess the current state of JLink development.

The experiment simulated three scenarios: armored, armored coalition, and light infantry battalions attacking against a defending company. All scenarios were executed in two contrasting environments. The simulation included the recently developed JLink features Family of Scatterable Mine (FASCAM) and chemical artillery.

The thesis used five Measures of Performance to base the assessment: 1) FASCAM kills, 2) Chemical Artillery Kills, 3) Detection Ranges, 4) Kill Ranges, and 5) Loss Exchange Ratio. The statistical tests used for analysis were the Analysis of Variance (ANOVA) test, two-sample t-test, and Wilcoxon test.

The results of the analysis show that JLink requires adjustments to artillery delivery methods in order to correct chemical artillery discrepancies and detection range issues. In general, JLink accurately portrays coalition warfare and satisfactorily replicates armored and infantry scenarios in contrasting environments.

THE USE OF CLASSIFICATION TREES TO CHARACTERIZE THE ATTRITION PROCESS FOR ARMY MANPOWER MODELS
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The U.S. Army has a system of large personnel-flow models to manage the soldiers. The partitioning of the soldiers into groups having common behavior is an important aspect of such models. This thesis presents Breiman's Classification and Regression Trees (CART) as a method of studying partitions relative to loss behavior. It demonstrates that CART is a simple technique to use and understand while at the same time still being a powerful forecasting tool. A CART example is included that provides the reader a thorough understanding of the method. The analysis explores the structure found in the current Classification Groups (C-Groups) used by the Army. CART is used to review the structure of the C-Groups and conduct some exploratory work to demonstrate that different combinations of factors result in greater internal homogeneity in forecasting. Recommendations are provided on how to approach the process of modifying the C-Groups. The use of CART results in obtaining insights into the Army force structure that would not have been found with any other forecasting technique. This thesis reveals the power of CART as a forecasting tool.

MODEL MANAGEMENT VIA DEPENDENCIES BETWEEN VARIABLES: AN INDEXICAL REASONING IN MATHEMATICAL MODELING
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The design and implementation of computer-based modeling systems and environments are gaining interest and importance in decision sciences and information Systems. In spite of the increasing popularity of GUI-based operating systems, most of the algebraic modeling languages, today, are still file-oriented, text-based, and therefore require structured declarations and formal model definitions. The utilization of the standard graphical screen objects of a graphics-based operating system provides enhanced visualization of models and more cohesive human-computer interaction.

The approach taken in this thesis is to explore the design and implementation of a graph-based modeling system focusing on computational dependencies between model components. Another important aspect of this research is the development of a user-friendly model formulation interface for algebraic modeling languages and systems; these facilitate the description and implementation of mathematical models by allowing the modeler to employ commonly known and powerful algebraic notation instead of language specific codes.

The major conclusion of this thesis is that dependencies between variables are a useful foundation for building and using models and modeling languages. It also shows that this supports model documenation, validation, formulation, implementation, comprehension, maintenance and reuse. That is, it impacts nearly every step of the modeling life cycle.

THE RULES OF ENGAGEMENT IN THE CONDUCT OF SPECIAL OPERATIONS
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This thesis examines the effect that ROE have on the conduct of special operations in order to contribute to an increased understanding of the proper employment of elite forces. It argues that "inappropriate" ROE can result from: 1) an imbal-

ance in the natural tension between the requirements of statecraft and military efficiency present in all military operations and 2) organizational friction resulting from inaccurate translation of broad political objectives, through various levels in the chain of command, into an inappropriate tactical ROE for a specific unit. Additionally, it argues that the nature of special operations, and the principles vital to their proper employment, cause them to be most sensitive to these sources of inappropriate ROE in either crisis or conflict. This thesis concludes that ROE can be used to achieve indirect political control over special operations, but achieving this control is more difficult and more hazardous with special operations than with conventional forces.

AN ANALYTICAL MODEL FOR EVALUATING AEGIS MISSILE DEFENSE EFFECTIVENESS
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The purpose of this thesis is to model the effectiveness of the Aegis combat system against supersonic anti-ship cruise missiles. The model takes into consideration the overall integration of all weapons and sensor systems on board, the availability and reliability of the weapons systems, the threat range at detection, the proficiency of the crew in employing the weapons systems, the threat range at engagement, and the probability of kill for each weapons system. This model is used to compare the effectiveness of the Aegis system operated by crews of varied proficiency with the effectiveness of the system using automated engagement systems. Additionally, a number of new, more potent weapons systems are proposed as additions to the Aegis system. An analysis of the resulting improvement in air defense capability due to the addition of these weapons and also the required level of automation for these systems is examined. The results of this analysis indicate that for certain cruise missile threats improved reaction time is more important than improved lethality for the Aegis system. Recommendations for the tactical employment of the system are given.

THE COMPARATIVE EFFECTIVENESS OF CONVENTIONAL SCHOOL-HOUSE TRAINING VS. INTERACTIVE COURSEWARE
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This paper reports the results of a study that compared the effectiveness of the traditional schoolhouse and an interactive multimedia system in training Repair Party Leaders. The study was conducted over a period of three months at the Repair Party Leader School, Fleet Training Center, San Diego, California. Subjects participating in the study ranged from mid-grade enlisted sailors (second class petty officers) to junior officers (Ensign through Lieutenant Commander).

Findings from three separate analyses are presented. The data analysis provides a basis for concluding that this system may be an effective way to deliver training to members of the shipboard damage control organization in a manner in keeping with the “Smart Ship” concept. Exit level of knowledge comparisons between personnel that used the IDCTT (RPL) as an augment to the standard RPL school curriculum and those that did not are examined, and final results and recommendations are provided. Recommendations for improvement of the system, as well as further research topics are also provided.

CLASSIFICATION ANALYSIS OF VIBRATION DATA FROM SH-60B HELICOPTER TRANSMISSION TEST FACILITY

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Health and Usage Monitoring Systems (HUMS) is an emerging technology in helicopter aviation. The United States Navy is evaluating its viability for use on its helicopter fleet. HUMS uses sensors placed throughout the helicopter to monitor and record vibration signals and numerous other aircraft operating parameters. This thesis evaluates the vibration signals recorded by a HUMS system using a statistical technique called tree-structured classification. The goal of the analysis is to demonstrate the technique's ability to predict the presence of faulted components in the transmission of the SH-60B autonomously operated in a Helicopter Transmission Test Facility at Naval Air Warfare Center, Trenton, New Jersey. The analysis is implemented in the statistical software package S-plus (Mathsoft Inc., 1995).

A MARITIME TRAFFIC CONTROL MODEL FOR THE VENEZUELAN NAVY

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The research area of this thesis is an operational issue of the Venezuelan Navy. The specific area of research is the development of a Maritime Traffic Control Model that guarantees the efficient accomplishment of surveillance and protection of the territorial sea. The principal task is reducing the number of potential illegal shipments, for example drugs, toxic waste, or other outlaw activities in the Venezuelan Sea.

Currently, several operational activities are executed as a response against illegal shipments. However, these operational activities require many resources and a considerable amount of time. These operational tasks depend primarily on intelligence efforts that represent a high financial cost and additional risky actions. For these reasons, the successful execution of the maritime control mission requires more dynamic and efficient approaches to maximize operational benefits.

This thesis develops and uses a stochastic decision making model, to analyze and set up inspection or interdiction operations in those areas whose geographic features represent closed transit areas for navigation. This decision model is intended to be an important aid for the execution of maritime traffic control operations in closed maritime areas in the Caribbean Sea under the sovereignty of Venezuela.

AN ADAPTIVE METHOD FOR THE ENHANCED FUSION OF LOW-LIGHT VISIBLE AND UNCOOLED THERMAL INFRARED IMAGERY

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Night vision sensors, such as image-intensifier (II) tubes in night vision goggles and forward looking infrared sensors (FLIR) are routinely used by U.S. naval personnel for night operations. The quality of imagery from these devices however, can be extremely poor. Since these sensors exploit different regions of the electromagnetic spectrum, the information they provide is often complementary, and therefore, improvements are possible with the enhancement and subsequent fusion of

this information into a single presentation. Such processing can maximize scene content by incorporating information from both images as well as increase contrast and dynamic range. This thesis introduces a new algorithm, which produces such an enhanced/fused image. It performs adaptive enhancement of both the low-light visible (II) and thermal infrared imagery (IR) inputs, followed by a data fusion for combining the two images into a composite image. The methodology for visual testing of the algorithm for comparison of fused and original II and IR imagery is also presented and a discussion of the results is included. Tests confirmed that the fusion algorithm resulted in significant improvement over either single-band image.

ANALYSIS OF AN IMPERFECT INFORMATION FLOW REDUCTION AND SORTING SYSTEM
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This thesis studies the employment of an information flow reduction and sorting system. The system is designed to reduce the amount of information gathered by a collection system to a rate that a user of that information can accept. The thesis demonstrates the benefits of trait-based analysis of information as a method of screening desired information from undesired. These systems increase the quality of the information reaching the user while adding a delay to achieve the screening process. A method of networking the screening devices is discussed. A sorting system is added to the screening process to demonstrate its ability to increase the speed of desired information through the system. The models are illustrated through numerical examples. The analysis provides the user of these systems with an understanding of their design, employment, benefits, costs, and calibration requirements.

FACULTY FORECAST AND PLANNING MODEL FOR THE NAVAL POSTGRADUATE SCHOOL
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This thesis develops a model for the Naval Postgraduate School (NPS) to forecast future tenure-track faculty size and distribution. It enables decision makers to analyze the effects of tenure and retirement policies as well as determine recruitment levels to achieve and maintain a desired number of faculty members.

The model estimates faculty retention characteristics, or continuation rates based upon the length of federal service (LFS) associated with historic loss data. These continuation rates are applied to a cross-sectional faculty profile to predict faculty legacies, i.e., the number of faculty who will continue service at NPS. Results show that faculty levels can be predicted with relative certainty out to a two-year horizon. Additionally, the results show how salary increases in the early 1990's induced a delay in faculty retirements.

An embellishment is presented also to the model which incorporates age-at-loss as well as LFS to forecast only retirements. The forecasts from this model are not as conclusive as those obtained from the original.

MODELING THE EFFECTS OF TECHNOLOGICAL CHANGE ON COSTS FOR DIVERT/ATTITUDE CONTROL SYSTEMS

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The purpose of this thesis is to produce a usable Cost Estimating Relationship (CER) or Cost Model for the solid-propellant Divert/Attitude Control System (DACS) used in the Atmospheric Interceptor Technology (AIT) program kill vehicle. While developing this CER, several other areas are investigated, including technology measurement and cost estimation of systems that incorporate advanced technology. The data sample for this analysis was collected by Tecolote Research, Inc., and includes both antiballistic missile interceptor and antisattelite attitude control system data.

The analysis includes review and application of a method to measure the level of state-of-the-art of technology embodied in an attitude control system. This methodology also includes the ability to measure the advance, or extension, of that state-of-the-art proposed by a new development program.

Theoretical first unit cost estimates for the ALT DACS are developed by using existing CERs and by first measuring the level of technology to be embodied in the DACS and then building a cost model from these technology measures. The models developed by this procedure show a smaller 90% prediction interval than the 80% prediction intervals produced by the traditional CER approach.

Central to this analysis is the use of various statistical analysis techniques, primarily factor, and regression analysis. Recommendations for further research are also provided.

EFFECTS OF PERSONNEL INJURIES ON CINC MISSION READINESS

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According to the Office of the Under Secretary of Defense for Acquisition and Technology, the Department of Defense currently does not have sufficient means of tracking and/or understanding the magnitude of problems associated with musculoskeletal (MS) injuries among its civilian and active duty personnel. The Naval Health Research Center (NHRC), San Diego, CA, has been conducting its own studies and research with regard to MS injuries incurred by Naval Special Warfare (NSW) personnel since October, 1993. One elite group within this community which was targeted for the research is the Navy SEALs. The purpose of this thesis is to determine the impact on operational readiness using the measure of effectiveness (MOE)—mission dependent man-days lost over time as a result of MS injuries incurred by Navy SEALs. Because NHRC has been seeking a database sufficient to answer such questions related to operational readiness, suggestions for software system design are provided. Results for man-days lost over time are presented for two missions, two mission segments, and three separate activities.

COMPARING TIME-BASED AND HYBRID TIME-BASED/FREQUENCY BASED MULTI-PLATFORM GEO-LOCATION SYSTEMS

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While time difference of arrival (TDOA) information is sufficient to passively solve for the location of a radio frequency transmitter, frequency difference of arrival (FDOA) information may be added to the TDOA information to solve for both the position and velocity of the transmitter. This analysis implements a stochastic discrete event simulation, written in Java, to compare and stochastically describe, under a variety of conditions, the differences between a mixed TDOA/FDOA Multi-platform Global Positioning System (GPS) Assisted Geo-location System and that of the same system which uses TDOA information only. The presented analysis compares both solution types for two- and three-dimensional fixes across: various measurement error distributions and correlation values, sensor network geometry, and sensor platform selection. The simulation results show first order stochastic dominance in the accuracy of the TDOA/FDOA solution in the two-dimensional scenarios. In the three-dimensional scenarios, sensor network to target geometry dominates both solutions' accuracy. While solution accuracy is used as the primary method of effectiveness, the distribution of each solution's uncertainty is also compared. Finally, the simulation itself remains a useful tool for further system design experimentation, performance indication, and as a means to describe system capabilities to the war fighter.

AN ADAPTIVE INSPECTION SAMPLING PROGRAM FOR DETERMINING COATING FAILURE OF NIMITZ CLASS AIRCRAFT CARRIER TANKS AND VOIDS

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This thesis addresses Nimitz class aircraft carrier tank and void maintenance. It contributes to the solution of current maintenance problems in four ways. First, it stratifies Nimitz class aircraft carrier tanks and voids into ten groups and assigns a criticality factor to each group. These groups and criticality factors can be extended to other classes of ships. Second, it demonstrates methods to estimate the survival function of tank and void coating lifetimes based on inspection data. Actual estimates of the survival function for each group are given, but are based on current data of questionable quality. Third, it develops a decision tool to plan inspections and budget maintenance costs over multiyear periods. Preliminary application of this tool demonstrates the cost effectiveness of driving maintenance by inspection. Finally, sampling plans provided to AIRLANT for CVN 711997 EDSRA and CVN 73 1997 SRA are discussed. These sampling plans were developed to obtain unbiased estimates of the current proportion of failed tanks within each group. By using plans such as these, unbiased estimates of the survival function for each group can be computed. This thesis provides a framework for developing a long term inspection and maintenance program.

DEVELOPMENT AND COMPARISON OF THE SH-60B USAGE SPECTRUM BASED ON HEALTH AND USAGE MONITORING SYSTEM DATA

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One possible bridge between continued high helicopter readiness rate requirements and restricted maintenance budgets is the Health and Usage Monitoring System (HUMS). This system, installed on one U.S. Navy SH-60B helicopter, is designed to monitor and record flight control positions, aircraft flight regimes and aircraft drive system vibrations in an effort to provide early notification of potential component failure and to provide a vibration trend analysis basis for component replacement. Currently, the U.S. Navy bases SH-60B helicopter component replacement on a predicted aircraft usage spectrum, which calls for component replacement after a fixed number of aircraft flight hours.

This research develops an aircraft usage spectrum from the detailed flight and aircraft parameter data recorded by HUMS and compares it with the current U.S. Navy SH-60B usage spectrum. Using the HUMS usage spectrum, component replacement times are calculated for four of the most frequently replaced SH-60B components and these results are compared with currently used replacement times for these components.

A MODEL OF U.S. ARMY RECRUIT LABOR SUPPLY

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In this thesis the author examines the military labor market and the effectiveness of the U.S. Army's enlistment bonuses and enhanced educational benefits of the Army College Fund on the recruit's labor supply decision. This paper reviews previous military manpower research and critically examines two recruit labor supply experiments —the Multiple Option Recruiting Experiment of 1979 and the Educational Assistance Test Program of 1981. Microeconomic principles of utility maximization are used to model U.S. Army recruiter objectives and behavior as a constrained optimization of the recruiters' utility function subject to a labor supply or production possibility frontier constraint. The reduced form model is a simultaneous system of lagged equations which are estimated using a generalized least-squares technique. To evaluate the effectiveness of recruiting incentives, estimates are obtained of the elasticities of high-quality male enlistments with respect to the Army College Fund and the enlistment bonuses. The results show that these programs are successful in attracting high-quality male recruits to achieve and maintain desired force levels.

AN ANALYSIS OF ALTERNATIVE METHODS TO CONDUCT HIGH-RESOLUTION ACTIVITIES IN A VARIABLE-RESOLUTION SIMULATION

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This study analyzes an original hybrid combat simulation for possible use as the underlying support model for the Joint Warfare Systems (JWARS) analytical simulation. The model employs a fixed-increment time advance mechanism but represents individual entities vice aggregated units. Results from an otherwise identical model using a next-event time

advance mechanism provide a baseline for comparison. The hybrid, using a longer time increment, runs faster than the next-event model but produces unacceptable results. The hybrid, using a smaller time increment, more closely approximates the next-event model but takes longer to run.

ANALYZING AND PREDICTING UNDERWATER HULL COATING SYSTEM WEAR

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The coating system of an aircraft carrier's underwater hull consists of two layers, an anti-corrosive under layer and an anti-fouling upper layer. The anti-fouling layer is a soft paint designed to ablate, continuously releasing toxins to inhibit marine growth. This feature causes the anti-fouling layer to wear over time with hull cleaning. Sufficient anti-fouling paint needs to be applied so that the anti-fouling layer remains effective through a ship's operational cycle until the next dry-docking availability. Naval Ship Technical Manual (NSTM) guidelines for how much anti-fouling paint should be applied are inadequate. NSTM fails to recognize that paint is not applied uniformly and that wear of the anti-fouling layer is also not uniform. Difficulties in implementing the guidelines are compounded by the fact that the anti-fouling layer cannot be measured directly. We propose a remedy for this situation. A simple method for estimating the distribution of the thickness of the anti-fouling layer is given based on measurements of the coating system before and after the anti-fouling layer is applied. In addition, a model is fit based on data from five aircraft carriers collected over ten years that predicts the change of the total coating thickness as a function of the number of years at sea, number of hydro-washes, and number of underwater hull cleanings. This model is simple, fits the data, and has been tested on an independent set of data. This model can be used to help decide how much anti-fouling paint should be applied so that it continues to prevent fouling of an aircraft carrier hull for a projected operational/maintenance cycle.

CHANGING THE VP RESERVE READINESS SYSTEM TO MATCH THE CREW-COORDINATION REQUIREMENTS OF RESERVE AIRCREWS

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Recently, the VP community has been identified as a force area where reserves could be used more in peacetime contributory support. The subsequent increased interaction between reserve and active VP forces has led to a similar readiness system.

The current VP readiness system promotes long-term, fixed crews with TACNUC rules. Adhering to these crew composition rules can cause considerable scheduling difficulties for reserve squadrons. Squadron readiness officers are often forced to change events, pick different crews, or turn the event into a practice session due to last minute civilian commitments of SELRES crewmembers.

This thesis examines current crew-coordination research to determine the value of keeping crews together. The study proposes alternatives to the current TACNUC rules and analyzes their perceived impact according to SME interviews.

This study recommends discarding the TACNUC rules in favor of a readiness system based on individual qualifications. The desired crew-coordination training can be accomplished through the ongoing TPC and ACT programs. Standardization of crew communication patterns and positional task expectancies should continue so that each individual crewmember can perform well on any crew.